[redacted]-7453-59

3 November 1959

[redacted]: Acting Chief, R&D

SUBJECT : A-C Power System for U-2C

1. During the periods of airframe modification, engine installation, and flight testing the J-75 equipped U-2C, extensive research and development effort has been expended to provide a 30KVA, 115/200 volt, 3 phase, constant 400 cycle A-C power system. This A-C power is necessary for the operation of the electronic reconnaissance equipments. The results of the various studies and testing programs have not been satisfactory in providing a capability consistent with previous U-2 operation. None of the four systems considered and/or tested gives such a complete capability. The desired parameters of system operation, weight, size, reliability, and complexity cannot be obtained with any one system. A practical compromise must be accepted, and it is imperative that a decision be made to determine the system desired for installation in the U-2C.

2. Four basic systems were studied and/or tested in the U-2C. The following is a brief outline of study and testing results:

a. Generator - Inverter System - The installation of a D-C generator with an inverter to convert D-C power to A-C power was rejected in the study phase. There are no suitable converters with 30KVA capacity within the feasible limitations of weight and size.

b. Constant Speed Drive System - The concept of a constant speed drive system was also rejected during the study phase. No equipment was available capable of being mounted directly on the engine. The only available engine drive pad was necessary for the D-C generator required for operation of the several aircraft systems. The constant speed drive and alternator would have to be mounted to the airframe and driven by a shaft through a very complex system of universal joints. With such a drive mechanism, there is insufficient space within the present airframe to install such a system without complete rearrangement of the engine compartment. An external pad to contain the system would cause additional drag with a resultant aircraft performance decrease.

c. Hydraulic Driven Alternator - A hydraulic system was designed and tested employing a pump, motor, and attendant equipment to drive the alternator. Due to the critical nature of the hydraulic system employed to operate the engine fuel booster pump, a separate hydraulic system was used. This system weighs approximately 75 pounds. Although the system is complex both in installation and maintenance, good frequency control is maintained during the mission profile. This system was the standard A-3 power system for all U-2's at the time of deployment to the field detachments. Subsequent failures of the hydraulic pump operating at the high engine RPM's dictated another investigation of the A-3 power system. LAC believed that a simpler, lighter, and cheaper method should be used to provide the capability. If a practical substitution could not be devised, then an improvement of the hydraulic drive would be required.

d. Direct Drive Alternator - A 5KVA, 115/200 volt, 3 phase alternator was mounted on the nose pad of the engine and is presently undergoing flight test at Edwards AFB, California. This system does meet the requirements of simplicity, weight saving, and less cost, but does not provide a stable 400 cycles per seconds frequency power source. During a normal mission profile, the frequency is 420 cps at full throttle and reduces proportional to throttle reduction during the cruise portion of the flight. At the end of approximately 7½ hours, the frequency has decreased to 350 cps. Alternate mission profiles can be flown to maintain higher engine RPM and thus supply a more constant frequency output. This can only be done, however, at a sacrifice of aircraft range capability.

3. In order to use either the Hydraulic Driven Alternator (c above) or the Direct Drive Alternator (d above) an additional R & D effort is required. To utilize the Hydraulic Driven Alternator, a better hydraulic pump must be installed. LAC has stated that no suitable pump presently exists to operate at 6100 RPM to 6720 RPM. Informal reports indicated the possible existence of a suitable pump. An investigation of this information with the Hydraco Division of The New York Air Brake Company disclosed serious doubt that any present pump (general limitations are 3000 RPM) could be satisfactorily modified or adapted to operate at the higher RPM's. To use the Direct Drive Alternator, the following alternatives can be applied:

a. The airplane must be flown at power settings higher than optimum in order to maintain a minimum frequency of 380 cps with a corresponding degradation in range.

b. The airplane can be flown at optimum range power settings and the electrical systems modified to operate at 350 cps. Systems III and VI can be modified to this profile by changing the system transformers. Such changes will require approximately six weeks. Systems IV and VII cannot be so modified to operate at this reduced frequency.

c. The Direct Drive can be modified to operate from 330 to 450 cps rather than the present 390 to 420 cps range. Such a change will require a complex design of a new gearbox to increase the frequency output and a rather extensive flight test program to measure system performance and reliability.

4. Although the weight of the hydraulic type system is more than that of the direct drive system, this is not in reality a weight increase since it was the original system installed with the J-75 engine. The hydraulic system offers the big advantage of constant A-C frequency regulation and no modification to present electronic systems. The weight saving of the direct drive system poses the limitations of a restricted flight profile or a complicated design problem of a new gear box. An alternate solution is to modify Systems III and IV could also be used. If the Direct Drive Alternator is accepted, no modification can be made to adapt System VII to the U-2C.

5. The cost of the presently installed Direct Drive system breaks down in the following manner:

Adapter	$ 117.00
Spline	142.00
Alternator	1,046.00
Misc parts and labor	225.00
TOTAL	$1,530.00

Approximately one week would be required to assemble the parts into form for shipment to Detachment "C". Four days are required for removal of the present hydraulic pump system and conversion to the Direct Drive system after receipt of parts. The airplane scheduled for delivery to "C" has the Direct Drive installation.

6. The cost of the modified gear box for higher frequency output is as follows:

Gear Box	$ 2,134.00
Alternator	1,046.00
Misc Parts and Labor	225.00
Flight Test of System	22,000.00
TOTAL	$25,355.00

7. In order to satisfactorily utilize the present gear drive, Systems III and VI must have larger capacity transformers. The cost per system modified is approximately:

System III	1 transformer change	$ 50.00
System VI	4 transformers change	200.00

8. Chalice Operations has indicated that there is no operational requirement to employ Systems IV and VII in a U-2 on an overflight mission.

9. Based on the foregoing information, it is concluded that the present Direct Drive System with transformer modifications to Systems III and VI provides the capability desired by Chalice Operations. In addition, acceptance of this A-C power source is the less expensive in both time and money.

10. The following recommendations are submitted:

a. The present Direct Drive A-C power source system be accepted.

b. All U-2's be modified with this system.

c. Chalice operations and Chalice communications jointly determine the number of reconnaissance Systems III and VI to be modified with larger transformers.

25X1

/s/

[redacted]

Chief, Developments

25X1

DPD-DD/P:[illegible] D.[redacted]amb

Distribution:

O & 1 - Addressee
1 - Ch/Ops
1 - Ch/Comms
1 - Ch/[illegible]
1 - [illegible]
1 - [illegible]
1 - Ch/[illegible]
1 - RI